SOOT STAINING AND STUMP HOLES: THE EFFECTS OF THE CERRO GRANDE FIRE ON PREHISTORIC CULTURAL RESOURCES AT LOS ALAMOS NATIONAL LABORATORY

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The Cerro Grande Fire

On 4 May 2000 the National Park Service ignited a controlled burn on the summit of Cerro Grande Peak in the Bandelier National Monument [Figure 1]. That night, strong winds blew the fire out of control, and on 5 May the controlled burn was officially declared a wildfire. The town of Los Alamos and surrounding communities were quickly evacuated as the fire moved dangerously close to homes. As wind speeds increased and fire fighters were unable to impede the progress of the fire, it continued to grow and rage uncontrollably – with 75 mile an hour winds, on the evening of May 10th alone 19,527 acres burned. The Cerro Grande Fire was not was not contained until 6 June, more than one month after it had started. While no lives were lost, we have only begun to understand the utter devastation caused by this wildfire to private and public property and to the area's cultural and natural resources.

A total of 47,650 acres were consumed by the Cerro Grande Fire, and more than 200 structures in the town of Los Alamos and 100 structures on Los Alamos National Laboratory (LANL) land were damaged or destroyed. Also damaged or destroyed by the fire were a wide variety of data and numerous projects that were stored or carried on at LANL. When the fire was finally contained, it had caused more than one billion dollars in damage.

The causes, nature, chronology, and consequences of the Cerro Grande Fire have been well documented in a number of reports (Department of Energy 2000; Los Alamos National Laboratory 2000, 2001a, 2001b). The impacts of the fire on the cultural resources of LANL and other agencies are just beginning to be understood and summarized; our paper is a contribution to this task (Masse et al. 2001).

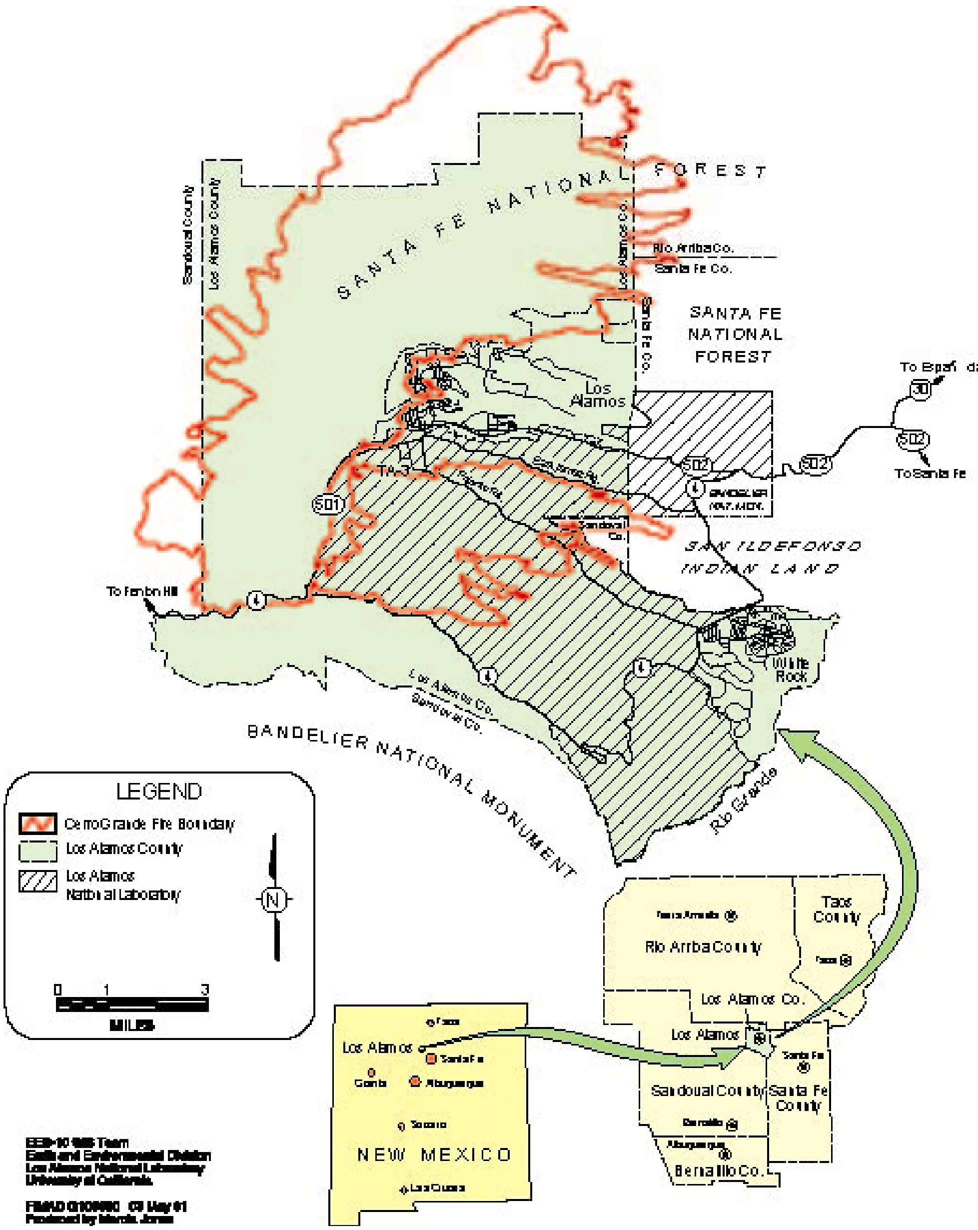

Figure 1. Los Alamos, New Mexico and surrounding areas

Cultural Resources at Los Alamos National Lab

The 111 km^2 of the Pajarito Plateau covered by LANL contain more than 2000 archaeological sites [Figure 2]. The sites at LANL span more than 7000 years, from the Early Archaic Period to the Homestead Era [Figure 3]. In addition, LANL itself contains a number of historic structures that are related to the Manhattan Project and the Cold War.

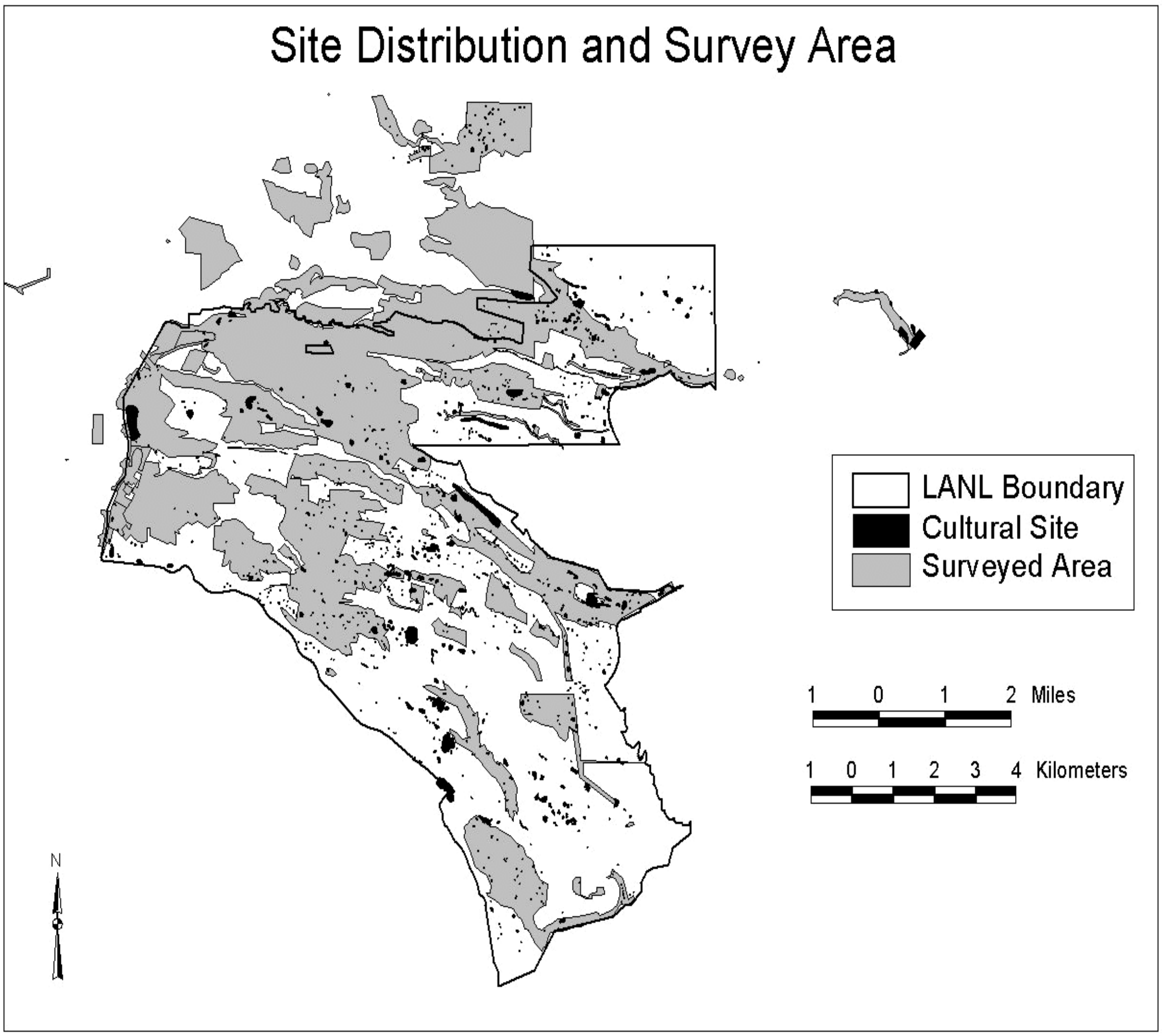

Figure 2. The cultural resources of Los Alamos National Laboratory.

Period	Phase Name	Dates
Paleoindian		9500-5500 B.C.
Archaic	Early Archaic Middle Archaic Late Archaic	5500 B.C.- -A.D. 600
Ancestral Pueblo	Developmental Coalition Classic	A.D. 600-1150 A.D. 1150-1325 A.D. 1325-1600
Homestead		A.D. 1890-1943
Manhattan Project		A.D. 1943-1945
Cold War		A.D. 1945-1963

Figure 3. The chronology of the Pajarito Plateau.

The oldest sites on LANL land are Archaic (5500 B.C. to A.D. 600); these are artifact scatters that represent the remains of temporary campsites. Early and Middle Archaic Period sites are present in small numbers, with Late Archaic sites are more common, this is due in part to the ephemeral nature of Archaic Period sites, but it is also the case that the Pajarito Plateau was not intensely occupied during these early eras (Masse and Vierra 2000:8-2, Vierra 1987).

The majority of sites on LANL land date to the Ancestral Puebloan Period (A.D. 600 to A.D. 1600). Ancestral Period sites are manifested on the landscape in a wide variety of site types including artifact scatters, 1 to 3 room structures, agricultural features, cavates, pueblo roomblocks, and plaza pueblos. The earliest in the chronology of the Ancestral Pueblo Period, the Developmental Period, is represented by a handful of sites; again because at this time the population on the Pajarito Plateau was relatively low. Population density increased during the Coalition Period (A.D. 1150-1325), when the Plateau experienced substantial population growth and immigration, this phenomenon is reflected in the hundreds of habitation and non-habitation sites that date to this period. As was the case throughout much of the northern Rio Grande area during the late Coalition period and throughout the Classic Period (A.D. 1350-1600), populations on the Pajarito Plateau began to decline, and inhabitants aggregated into smaller, larger pueblos, like that of Tsirege [Figure 4] (Creamer 1993; Crown and Kohler 1994; Crown *et al* 1996).

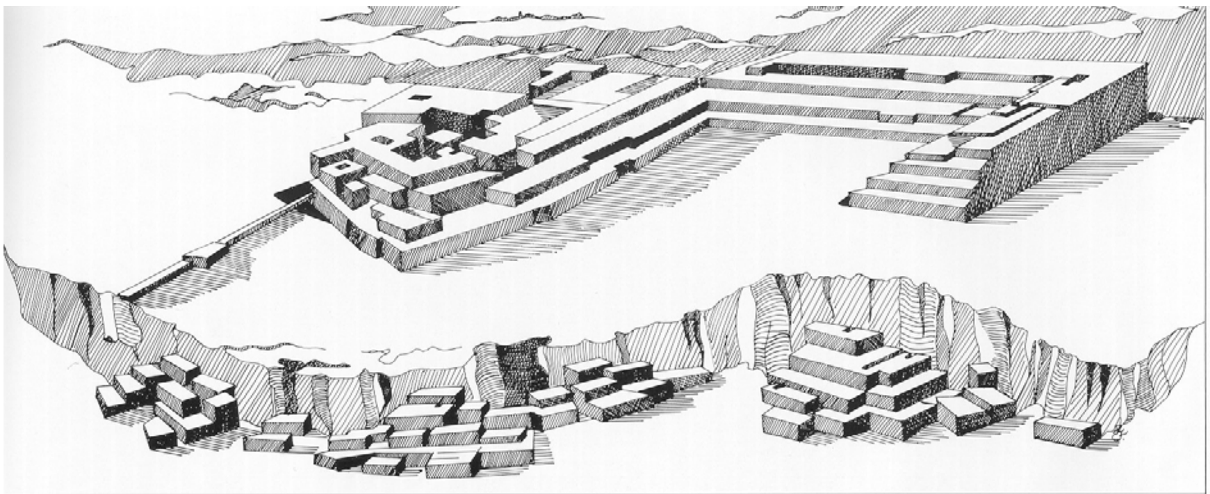
The pueblo of Tsirege consisted of multistoried masonry buildings

Figure 4: Reconstruction of Tsirege

By A.D. 1600 Puebloan people had largely abandoned the Pajarito Plateau as a residential area, and as a result, there are almost no known archaeological sites until the beginning of the Homestead Era in A.D. 1890.

The Cerro Grande Fire and LANL Cultural Resources

The Cerro Grande fire affected approximately 7,650 acres of LANL property and approximately 480 acres of land in the Rendija Canyon Tract, an area also owned by the Department of Energy (DOE) and administered by LANL [Figure 5]. As of May 2000 we knew of approximately 500 sites within these 8100 acres. It was the task of the LANL Environmental Safety and Health (ESH)- 20 Cultural Resources Management Team (CRMT) to assess the damage caused by the fire to these sites, as well as that caused by fire suppression and rehabilitation activities. The data gathered from this assessment are currently being used to plan rehabilitation and mitigation efforts for impacted sites and to create a baseline for future monitoring. In the following sections, we discuss the methods used to conduct site assessments, our findings about the impacts to ancient sites, and our plans for future rehabilitation and mitigation.

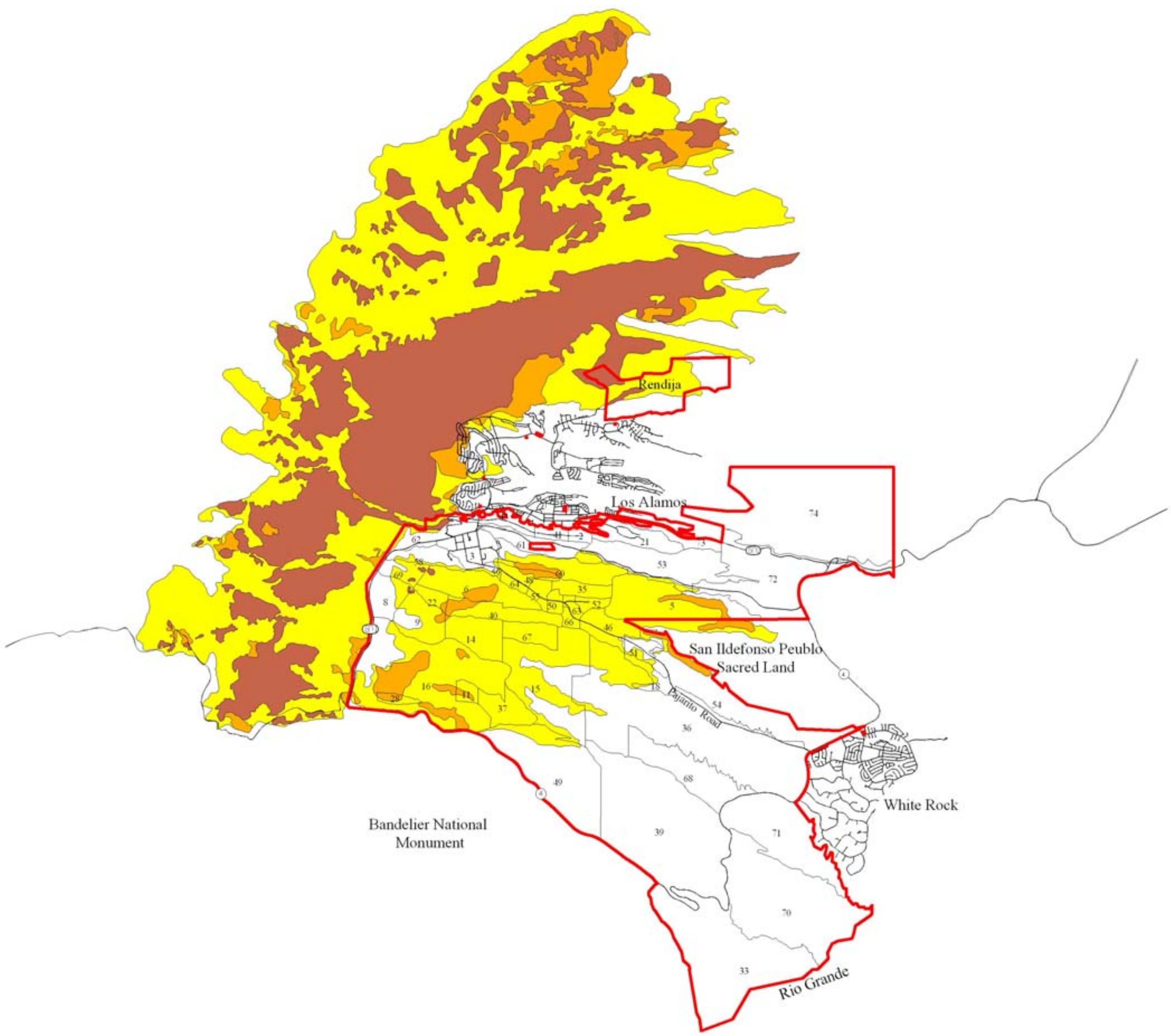

Figure 5. The extent of the Cerro Grande Fire.

Field Procedures

To document the fire, fire suppression, and rehabilitation impacts, and to record rehabilitation recommendations, a team of archaeologists visited each known LANL site in the burn area (although about 5% of the sites were not relocated during the study). The Cerro Grande Fire Assessment form [Figure 6] was used by the CRM Team to guide site fire assessments. The CRMT form was based on one previously created by the Burn Area Emergency Response (BAER) Team, we made several modifications to the form, so that it was well suited to our specific needs. The core of the form consists of a checklist for evaluating the fire severity in the immediate site vicinity, as well as the kinds of suppression and rehabilitation impacts present at sites. Fire severity was determined using a list of criteria. For example, partially burned duff, a lack of ladder fuel consumption, and no canopy burning characterize a low burn area. A moderate burn area is characterized by consumption of duff, and ladder fuels, as well as isolated instances of isolated crown burns. Severely burned areas were locations in which the duff, crown, and canopy were completely consumed.

CERRO GRANDE FIRE
LOS ALAMOS NATIONAL LABORATORY POST-FIRE SITE INSPECTION RECORD

SITE: No: LA________________ Temp or other No: _____________ Bldg. #_________ TA # _________
Recorder(s)____ Date of Inspection _______________
UTM (GPS) Z13 ______________E _______________N Elev.: ___________ USGS Quad:_________________
SITE DESCRIPTION [Note: See GIS/database codes for definitions and list of acceptable Others]
Site Period: Unid. Prehistoric___; Archaic___; Unid. Pueblo___; Coalition___; Late Coal./Early Classic___; Classic___; Unid Historic___; Homestead___; Manhattan___; Cold War___; Unid.___; Other_______________
Site Type: Small Roomblock___; Complex Pueblo___; 1-3 Room Structure___; Lithic Scat.___; Art. Scat.___; Cavate___; Trail/Stairs:___; Historic Structure___; Historic Trash___; Other__________________________________
Features Present:____
Previously Unidentified Features Present:____
List wood/organics (if known to be present): ____
Were they burned? Yes___; No___; Partial___
Comment____
Physical/environmental hazards, if any:____
VANDALISM PRESENT: YES___ NO___ If yes, RECENT___ OLD___ UNKNOWN___
SITE BURN SEVERITY [Note: Map, photograph and describe affected areas of site]
___ None
___ Low (duff partially consumed, none to little ladder fuels burned, no canopy burned)
___ Moderate (duff consumed, ladder fuel burned, isolated crown burn or torching)
___ Severe (duff, ladder and crown completely consumed)

FIRE EFFECTS AT SITE	**YES**	**NO**	**# or %**	**COMMENT**
Cracking/spalling on masonry….................................	___	___	__________	____________________
Smoke/soot damage on masonry	___	___	__________	____________________
Stump/root holes on or adjacent to masonry..............	___	___	__________	____________________
Additional Stump/root holes in site area….................	___	___	__________	____________________
Loss of architectural wood/features............................	___	___	__________	____________________
Fallen tree(s) on walls or rubble............................... .	___	___	__________	____________________
Snags/partial burned trees that can damage structures	___	___	__________	____________________
Additional snags/partial burned trees in site area	___	___	__________	____________________
Other ________________________________	___	___	__________	____________________

SUPPRESSION IMPACTS TO SITE: YES___ NO___ Handline__; Dozer line/firebreak:__; Tree falling:__; Cache/Camp ___; Vehicle ruts ___; Other_______________; Comments_________________________________
EROSIONAL THREATS TO SITE : None_____ Low_____ Moderate to High_____
Erosion threat: Active gully/rilling/scouring (depth and extent) __________ Stumphole/burned log erosion ____ Pedestaling ___ Duff absent _____ Other(describe)____
Comments____

REHABILITATION AT SITE: YES _______ NO_______ Describe:__________________________________
____

RECOMMENDED PRESERVATION TREATMENT AND/OR DATA RECOVERY
____ NO TREATMENT ____MONITOR ____TREATMENT ____DATA RECOVERY
Describe recommended treatment (Directional falling; straw bale; root hole filling; Excelsior matting; wattles; etc.):
____
Describe recommended data recovery____
____
PHOTOS: ________________ **GPS**:_________________ **Additional comments on back ?** Yes___ No___

Figure 6. Cerro Grande fire assessment form.

A list of fire impacts including crackling and/or spalling on masonry, smoke or soot staining on masonry, stump and/or root holes on or adjacent to masonry, stump and/or root holes elsewhere on the site, loss or architectural wood, fallen trees on masonry, snags (dead but standing trees) that have the potential to damage structures, and snags present elsewhere on the site was part of the CRMT form. Some of these impacts cannot be mitigated, however it is important to document all damage for future monitoring; and in fact some factors are indicative of where the fire occurred at the site. Crackling or spalling on masonry may in the future translate to an increased susceptibility to erosion and/or deterioration. Surveyors have also recognized that smoke or soot staining on masonry is largely temporary. Recent visits to sites that were fire assessed about a year ago reveal that a great deal of soot and smoke staining had been washed away by rain and snow. Again, the utility of recording smoke and soot staining is in its potential to indicate the distribution and intensity of fire at a given site.

Other impacts are more easily mitigated, for instance, stump holes create avenues for erosion and can potentially bring about the mixture and contamination of surface and subsurface deposits; filling in stump holes helps to prevent such impacts. The danger posed by snags at a typical site is not that they will fall onto the structural remains; in fact in the few observed instances of this occurrence there was little or no damage; but rather, the real potential for damage arises from a tree falling over and pulling up its roots. Root damage displaces masonry, disturbs subsurface deposits, and creates avenues for erosion. If snags are left in place, they remain potential fuel for future fires. Removal of snags from within the site vicinity eliminates their threat to masonry and site stability.

Fire impacts are not the only threats to archaeological sites at LANL. Sites also were potentially subject to fire suppression impacts and rehabilitation activities. During the fire, dozer lines cut for firebreaks, tree felling, and staging area activities were plentiful and often had devastating effects at sites. These disturbances were recorded as part of the fire assessment project.

Because of the potential for long-term effects at impact sites an attempt was made to at least qualitatively assess potential erosional threats at a site. The erosion category on the CRMT form proved to be one of our most difficult evaluative tasks, the team came to find that it was not possible to develop a set of measures that could be consistently applied in the field by the various assessment team members. Several factors, such as the general degree of the site slope and the amount of overall vegetation loss, were recorded, and on the basis of that data we divided erosional impacts into four categories, none, low, medium, and high.

Taking all of the information recorded on the form into account, team members then made in-field assessments of the kind of treatment, if any, was recommended for a site. Recommendations include directional tree felling, stump hole filling, snag removal, wattle placement to reduce erosion, future monitoring, and data recovery. These recommendations continue to be subject to re-evaluation.

In addition to the data on the form, CRM Team assessors shot a minimum of two photographs at each site to create a visual baseline for future monitoring. The team also recorded the location of each site using Global Positioning System (GPS) equipment. GPS data provide for creation of a database that includes accurate locations for sites on LANL land, these data can also be used to aid in an efficient return to previously documented sites.

Results

As of 1 March 2002, just over 500 sites had been fire assessed; 10% of these sites were previously unrecorded. Some of the new sites were located in previously unsurveyed areas; others became visible when the fire burned off duff and dense vegetation that had previously obscured the features at a site. Not all of the sites we visited had fire damage, even though they were located within the burn area. One hundred and forty sites, or approximately 35% of all assessed sites, fall into this category; most of these sites are located in areas that were impacted by a low burn according to fire intensity maps. In reality, these 140 sites were located in unburned areas as assessed by field crews.

Of course many sites did not escaped unscathed. The most severely impacted sites, as a class, are masonry structures, including pueblos, field houses, and an assortment of other structures that fall under the rubric "rock feature" (e.g. check dams, rock piles, garden plots, etc.). Figure 7 illustrates that all types of masonry structures sites were affected in a similar manner; although, pueblos were slightly less likely to be impacted by any given effect. Most pueblos are located in the piñon-juniper zone, or in the ecotone between the piñon-juniper woodland and the ponderosa pine forest: that is, pueblos are for the most part surrounded by a smaller fuel load than other sites (Vierra and Balice 2001). Damage to masonry structures at sites is quite varied.

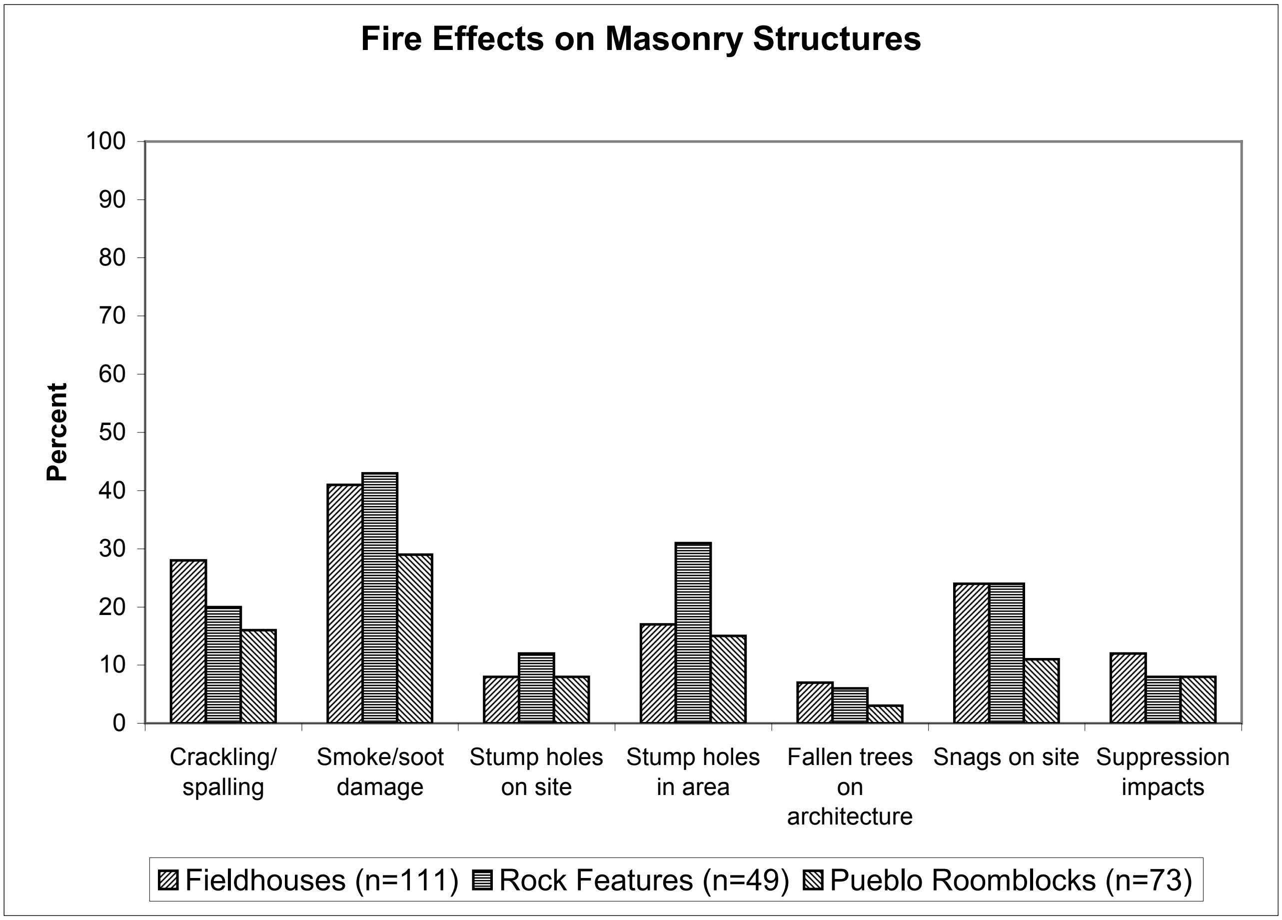

Figure 7. The effects of the Cerro Grande Fire on masonry structures at LANL.

Smoke or soot damage is the most common affect, but even this is present at less than fifty percent of the sites. Less common, but in fact more destructive, was the presence of crackling and spalling on masonry. When crackling and spalling did occur, usually less then a quarter of the masonry was affected, although in a few instances, virtually all of the masonry was spalled. Stump holes were particularly common in ponderosa pine trees areas that were subject to moderate and high intensity burning. The presence of fallen trees on architecture was not common, however, snags do pose potential future threats to sites because they are fuel for future fires and because if they do fall, they create new avenues for erosion.

Impacts to sites from suppression of the fire ranged from relatively innocuous (i.e. vehicle ruts) to very destructive; in some cases masonry blocks from field houses were used to anchor tents in the suppression camp. Three field houses were almost completely destroyed by dozer-lines. Fortunately, these highly adverse impacts were very rare, and less than half-dozen sites were so affected.

Fire damage to cavates [Figure 8] was infrequent and minor, and in general these features weathered the Cerro Grande fire quite well. There is, however, one significant potential research issue created by the fire. The interiors of many cavates were deliberately smoke-blackened as part of their original construction. These carbon deposits have the, albeit untested, potential to yield radiocarbon dates. It is not known if soot from the Cerro Grande fire caused contamination problems for radiocarbon dating.

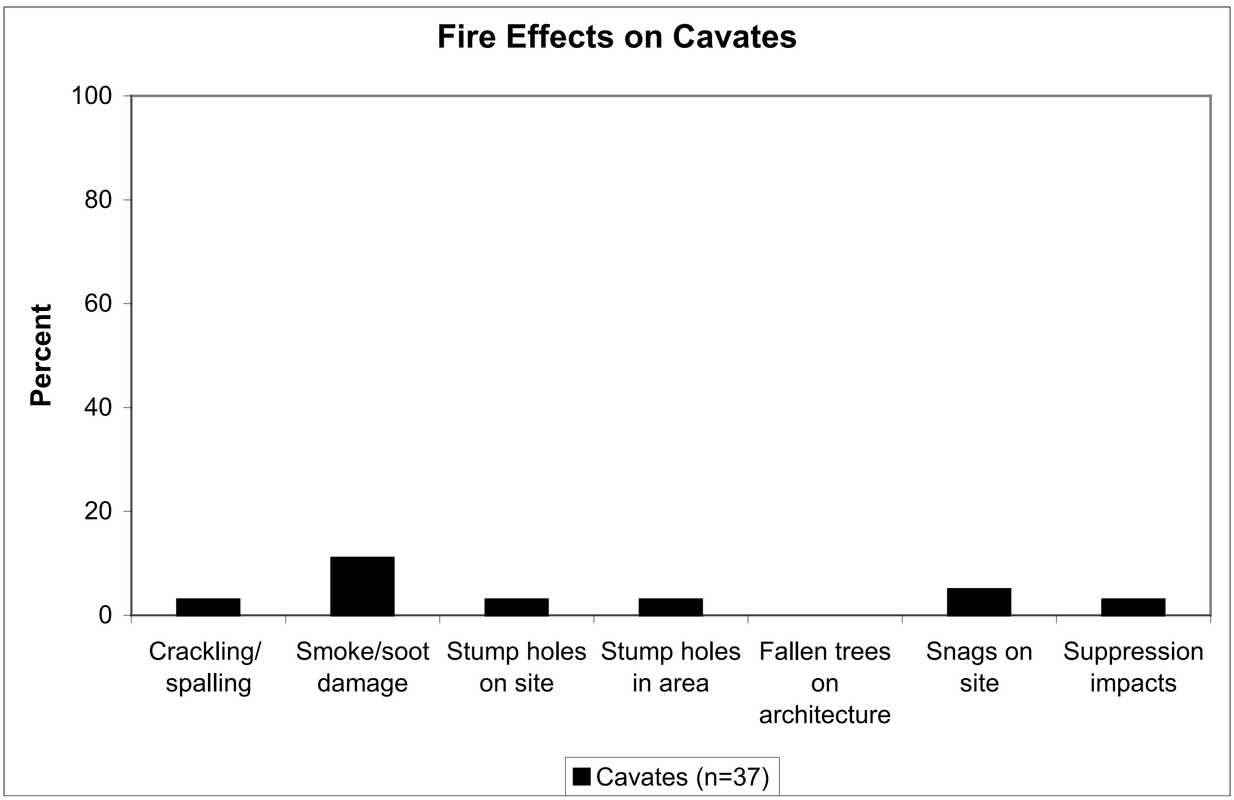

Figure 8. Fire effects on cavate features at LANL.

Non-structural sites, namely artifact scatters, were impacted in ways that differ from structural sites. The main impact to artifact scatters is from erosion, and the potential threat of erosion created by a loss of vegetation, fallen trees, and snags. There were some suppression impacts at these sites, but these were usually rather minor.

Certainly the intensity of the fire in specific areas determined how likely a given site was to suffer any given type of impact. Figure 9 illustrates the frequency of effects on masonry structures by burn intensity. Burn intensity, reflected in Figure 9, refers to our on-the-ground determination, not the burn areas depicted on the map. As can be clearly seen in this figure, the hotter the fire, more likely a site was to be affected by any given impact. The "stump holes in the site area" category is a curious exception, and we can offer no explanation for it at the current time.

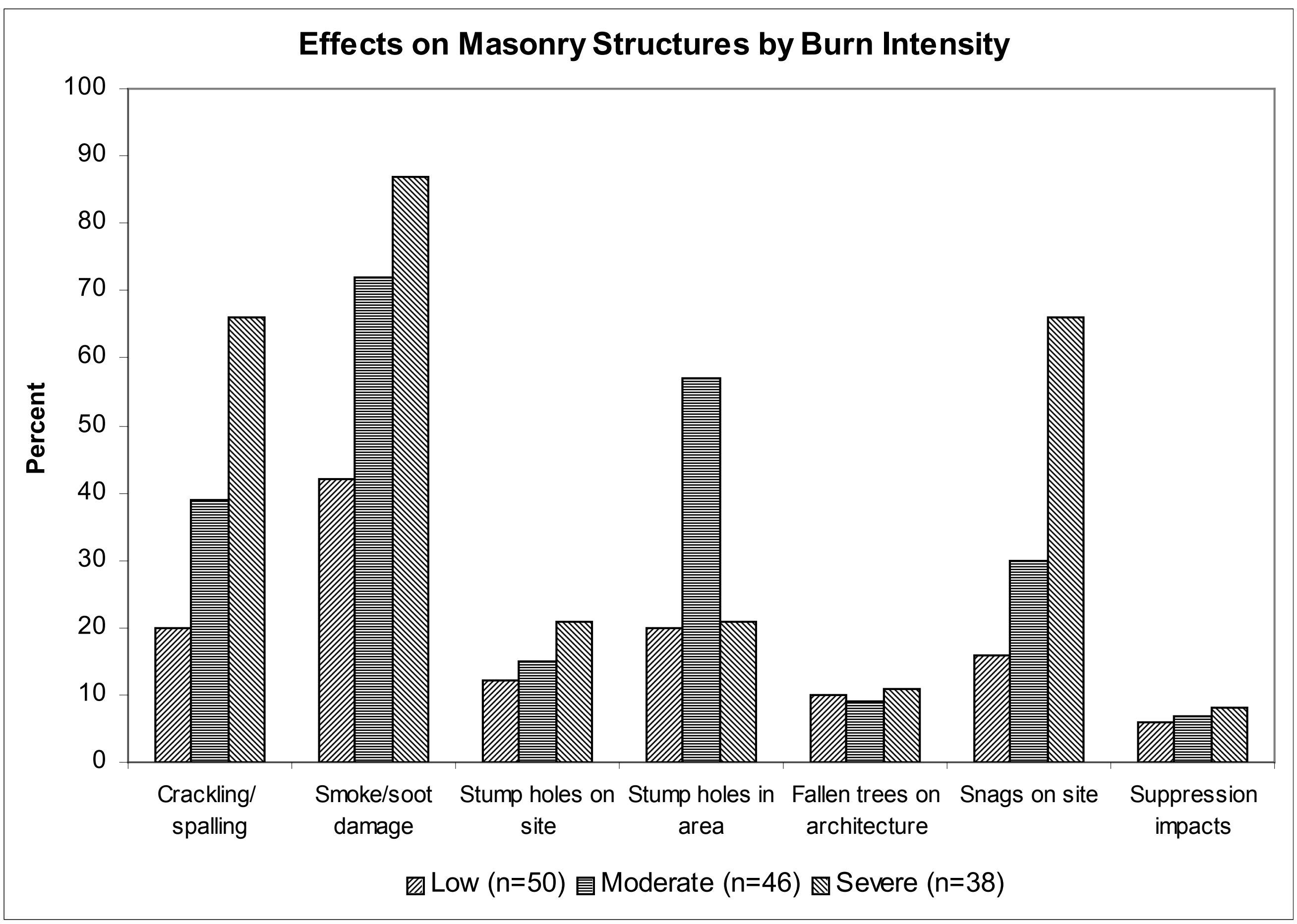

Figure 9. Burn intensity and fire effects to masonry structures.

A great deal of information about wildfires comes from mapping tools including Geographic Information Systems (GIS). For this reason, we felt that it was important to consider the differences (if any) between idealized databases depicting the fire, and the assessments made by field crews sent into fire areas to determine the extent of the fire. Using the Cerro Grande fire GIS database, we compared the assessed severity of the burn and the actual burn severity at archaeological sites. Table 1 depicts the findings of a cross-tabulation that compares the two databases. Interesting findings in this cross-tabulation are that in some cases the field crews assessed an area as having a low or moderate burn even though the GIS coverage of the area showed no burning. There does appear to have been consistency in the assessment of areas depicted as severely burned by GIS coverage. Low burn areas were the most common in the GIS database, although field crews found a wide range of variation in the actual degree of burn on the ground at archaeological sites. In fact, the majority of variation in assessments is visible at sites that were identified as low burn areas.

Burn Severity as assessed by CRM Team	**Burn Severity based on GIS Coverage**				**Total Number of Sites**
	None	Low	Moderate	Severe	
None	X	90	1	0	**91**
Low	11	81	4	0	**96**
Moderate	4	75	5	0	**84**
Severe	0	37	7	11	**56**
Total	**15**	**284**	**17**	**11**	**327**

Table 1. Burn severity based on GIS coverage cross-tabulated with burn severity assessment of Cultural Resources Management Team (X= category not included in this analysis).

A View To The Future

There are three major tasks that the fire assessment team hopes to accomplish in the next two years in terms of understanding and dealing with the Cerro Grande fire at LANL. The first of these is to complete the compilation and analysis of data gathered during the fire assessment project. These data will be included in a published summary report intended to assist resource managers at LANL and to provide insights into wildfire management that may be of use by other land management agencies.

The second task is to embark on a modest program of rehabilitation and protection at selected archaeological sites on LANL property that were impacted by the Cerro Grande fire. This program includes removal of snags and fallen trees, filling in stump holes, implementing erosional control measures, and protecting sites situated near fire roads and in the vicinity of designated emergency operations areas. An important aspect of this rehabilitation project is cooperation with our neighbors from the Pueblos of San Ildefonso, Santa Clara, Cochiti, and Jemez. It is our intention to consult with them on this project, and also to put together a program that enables the Pueblos to work side-by-side with the LANL Cultural Resources Management Team during the rehabilitation fieldwork.

The third and final task is to design and implement a long-term site-monitoring program. This program will be used not only to monitor the damage incurred by selected archaeological sites, but will also be used to judge the overall success of the site rehabilitation program. The results of the monitoring program, like that of the initial damage assessment, will be made available to other land management agencies.

References Cited

Creamer, Winifred

1993 The Architecture of Arroyo Hondo Pueblo, New Mexico. *Arroyo Hondo Archaeological Series*, Volume 7. School of American Research Press, New Mexico.

Crown, Patricia L., and Timothy A. Kohler

1994 Community Dynamics, Site Structure, and Aggregation in the Northern Rio Grande. In *The Ancient Southwestern Community: Models and Methods for the Study of Prehistoric Social Organization*, edited by W.H. Wills and Robert D. Leonard, pp. 103-117. University of New Mexico Press, Albuquerque.

Crown, Patricia L., Janet D. Orcutt and Timothy A. Kohler

1996 Pueblo Cultures in Transition: The Northern Rio Grande. In *The Prehistoric Pueblo World, A.D. 1150-1350*, edited by M.A. Adler, pp. 188-204. The University of Arizona Press, Tucson.

Department of Energy

2000 *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico*. DOE/SEA-03. Los Alamos, New Mexico.

Los Alamos National Laboratory

2000 *A Special Edition of the SWEIS Yearbook: Wildfire 2000*. LA-UR-00-3471. Los Alamos, New Mexico.

2001a *Out of the Ashes: A Story of Natural Recovery*. LALP-01-20. Los Alamos, New Mexico.

2001b *Cerro Grande: Canyons of Fire, Spirit of Community*. Los Alamos, New Mexico.

Masse, W. Bruce

2001 *Pajarito Gas Line Project: Archaeological Survey Along the Route of the Proposed Pajarito Gas Line Corridor Los Alamos National Laboratory, New Mexico*, Cultural Resources Report No. 194. LA-CP-01-382. Los Alamos, New Mexico.

Masse, W. Bruce and Bradley J. Vierra

2000 Site Distribution. In *Cultural Resource Assessment for the Department of Energy Conveyance and Transfer Project*, edited by S.R. Hoagland, B.J. Vierra, and W.B. Masse, pp.8-1-8-33. Cultural Resource Survey Report No. 176. LA-CP-00-179, volume 1. Los Alamos, New Mexico.

Vierra, Bradley J.
1987 Regional Archaic Mobility Patterns. Paper presented in the symposium on *The Archaic of the Northern Rio Grande* at the 60th Annual Meeting of the Pecos Conference, Pecos Pueblo, New Mexico.

Vierra, Bradley J. and Randy G. Balice
2001 Fuel Loads and Wildfire Effects on Archaeological Sites at Los Alamos National Laboratory. Paper presented at the conference on *Wildfires and Cultural Resources*, Santa Fe, New Mexico.